Your New Car

Published By
The Perfection Spring Company,
Cleveland, Ohio.

Dedicated

To

Truth and Accuracy

General View of Plant No. 2 of The Perfection Spring Company

Foreword

OWNERS of the makes of automobiles fitted with Perfection Springs will scarcely have occasion to obtain repairs—*Perfection Springs do not break in normal service, if at all!*

BUT, the owners of the makes of automobiles which are not fitted with Perfection Springs, since they do experience breakages in even restricted service rendered, are compelled to have their broken springs replaced—*or, do without the service of their cars.*

CLEVELAND, with its 20,000 owners of automobiles, is also headquarters for a large number of broken springs—*because not a few of these automobiles are not fitted with Perfection Springs.*

STILL, there is no sufficient reason why any Cleveland owner of a car should suffer any longer than the few hours required to replace broken springs with unbreakable springs—*Perfection Springs!*

WHEN Mr. Christian Girl started the Perfection tion Spring Company, he *delivered* his message of quality to the makers of automobiles wrapped up in loyal springs for their automobiles.

THE Perfection Spring Company did not at first get all of the sturdy-going spring business, because all of the makers of sturdy automobiles did not know that Perfection Springs were the best from the first *but they have learned at last.*

TODAY, if you want a shining-light automobile, all that you have to do is to be sure that it is fitted with Perfection Springs; the rest follows as a matter of course. If you want to improve your own automobile, run it into the new Service Depot of the Perfection Spring Company, situated at 2008 East 65th Street (just off Euclid), Cleveland, where skilled men in spring suspension work will quickly replace your broken or wilting springs with Perfection Springs, or improve your car by heat-treating the shoddy irons that annoy you so much on the road.

HOWEVER, you may not require spring service to-day —you may never require springs if your car is fitted with Perfection Springs—but, how about next week? How about your springs? Are they Perfection Springs? If not—and they break—will you be content to again risk your life (and the lives of your family) or, will you drive around to the Perfection Spring Service Depot, 2008 East 65th Street, Cleveland, and even though you are not now in need of service, request the manager to just show you around—he'll be delighted to meet you!

YOU may live out of town. If so, and you need servvice, this company undertakes to ship complete springs or separate plates for springs (from stock) *via* express or parcels post to any part of the United States. It may not be quite convenient for you to pay a personal call at the Perfection Service Depot. In that event, you may not be quite familiar with the growth and girth of the Perfection Spring Company. You may never have seen the magnificent spring plant known as No. 2 of the Perfection Spring Company, located at Central Avenue and East Sixty-fifth Street, nor would you be acquainted with "old" No. 1, with its hum of industry; the plant where Mr. Girl first instituted scientific spring making and, where the finest brand of steel in the world —Krupp steel, all the way from Essen, Germany, in the hands of Master Spring-Maker McIntyre, sowed the seeds

for the largest spring plant in the world—the magnificent new plant at Central Avenue and East Sixty-fifth Street.

IF you live out of town; if you can't take the time to visit the new Perfection Service Depot, write a letter telling the make and model of your car; ask the company to replace your broken or defective springs with Perfection—Krupp springs.

IN any case, if you have never had Perfection Springs on your automobile, you will probably think that we have got to tinker with shock-absorbers. The reason why you have contracted the shock-absorber fever is because your springs are bad—replace your poor springs with Perfection Springs—it is not so costly; the results are better. Then, too, you will be dealing in a certainty —*a dead moral certainty,* with a guarantee as long as your arm and as big as your thigh.

IN order to insure prompt future service against the day when your springs may break, fill in the coupon leaf of this book and mail it to:—

The

Perfection Spring Company

Central Ave. and East Sixty-fifth St.

Cleveland, O.

Looking at the new Service Station of The Perfection Spring Company, Cleveland, O.

Interior View of the new Service Station of The Perfection Spring Company, Cleveland, O.

Perfection Spring Company
Central Avenue and Sixty-fifth Street
Cleveland, O.

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GENTLEMEN:

My automobile is operated under:—

State license No.__________ State of __________

Make of Car__________ Chassis No.__________

Model __________ Year______ 19______

Style of Body__________ Seats __________

Remarks ____________________

Please register my car in your service record in order that, should the springs get soft or break, I will be enabled to call upon you for quick replacements or repairs, with the understanding that I am under no obligation to you in thus placing my name before you.

Sign____________________

________________Street

__________City __________State

Note

Upon receipt of this Coupon Page, we will place the data given in our files, at the same time mailing you complete forms and instructions for ordering repairs from us whenever needed.

This method will simplify your orders and facilitate delivery, as we aim to make shipment immediately upon receipt of order.

Research Effort Brings Rich Reward

ABOUT ten years ago the world was set agog by the announcement that two great French chemists, M. and Mme. Currie had discovered and isolated a new and wonderful element, radium. Yet, it is little known that radium had been prophesied, weighed, named and catalogued many years previous. The same is true of many other elements that have been isolated during the more recent years, as well as many others that have not yet, but doubtless will be, isolated. In this matter-of-fact-show-me era this statement suggests magic, and yet it is simple and reasonable when understood.

The rainbow of legend and romance with its "pot of gold" has been transplanted in the laboratory and forced to give up its secrets. The cold, calculating eye of science has robbed the rainbow of its mystery and used it to reveal what nature had long concealed.

It is now a well-known fact that the rainbow is produced by sunlight falling upon rain-drops and being thereby broken up into its colors. The rainbow, of course, takes the form of a circular curve because the rain-drops are spherical.

The same effect of breaking up sunlight into its colors can be produced with a glass prism, though the resulting color band takes the form of a straight line if the prism is straight. This color band is called the spectrum and, when produced by the direct rays of the sun, the colors visible to the human eye blend in a beautiful manner from violet through blue, green, yellow and orange into the reds. Colors (invisible to the hu-

man eye) no doubt exist beyond both ends of the color band, and, for want of better names, are called ultra-violet and infra-red.

Scientists, as a basis of investigation, assume that sunlight is the light given off by the luminous vapors of the sun, such vapors being produced by combustion. The clear, pure white of sunlight is due to the presence of all the colors. The reverse of this statement can be proved by taking a printed reproduction of the sun's spectrum and pasting it on the edge of a disc. If this disc is revolved rapidly the eye is given the impression of white.

If a ray of sunlight is passed through a glass prism, not only is the direction of the ray changed, but the white light is decomposed into colors; it suffers dispersion. It will be found that the red rays are deflected the least, while the violet rays are most deflected. (Fig. 1) The picture obtained—the spectrum—does not show the colors sharply separated, but merging into one another. Such a spectrum is called a continuous, or uninterrupted spectrum.

A glowing vapor or gas behaves quite differently. It does not emit white light, like sunlight, but light composed of certain definite rays, which are characteristic for each gas or vapor. The light emitted from glowing vapors, or gases, when decomposed by the prism, yields on the screen an interrupted spectrum. If the light is passed through a fine slit before reaching the prism, the spectrum will be found to consist of a greater or less number of colored lines which always appear in the same position with any given substance, providing the prism or its position, is not changed.

Continued and exhaustive study and trial brought out the fact that each element or substance, when burned,

throws a line on the spectrum, the position of which is always the same for the same substance when compared with the sun's spectrum. When this fact was proven, the various known earthly elements were rapidly studied and their characteristic lines on the spectrum catalogued. For example: We know that if we throw common table salt (composed of two elements, sodium and chlorine) into a flame, a yellow vapor is quite evident. This is the sodium. If the light from this vapor were passed through a slit, thence through a prism onto a screen, a sharp line would appear in exactly the same position as the yellow in a spectrum from sunlight.

For convenience of investigation, the spectrum of sunlight has been fixed as a standard and divided into definite numbered spaces in order that the location of any line can be catalogued by letter or number, thus designating its fixed location.

When catalogued in this manner it was simple to compare the physical and chemical properties of the various elements that have neighboring lines on the spectrum.

The age of this wonderful study can be better appreciated when it is known that Sir Isaac Newton (credited with the discovery of the law of gravity) first experimented with a glass prism in 1666. The sun's spectrum was first charted in 1802 by Fraunhofer when

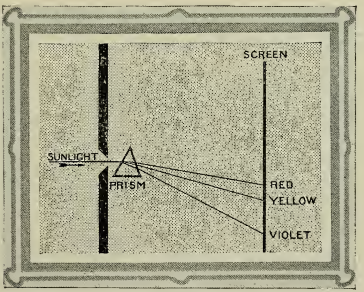


FIG. 1

Rays of sunlight passing through glass prism illustrating deflection and dispersion

he lettered the various spaces of the color band from A in the reds to H in the violets. These designations of Fraunhofer are still retained in an amplified condition and are known as Fraunhofer lines.

The complete cataloguing of all the known earthly elements in a form wherein they could be studied, revealed the fact that there were quite a number of blank spaces that could only be accounted for by the assumption that there were some substances indicated in the sun's spectrum that had not yet been discovered on earth.

The similarity of the activities and characteristics of known elements whose spectrum lines were related or neighboring, led the scientists to assume that if one of these unknown elements represented by the blanks were to be found, it would prove to have characteristics resembling its known neighbors. This proved to be a correct assumption, for as soon as advancing science began to isolate and identify some of these unknowns, it

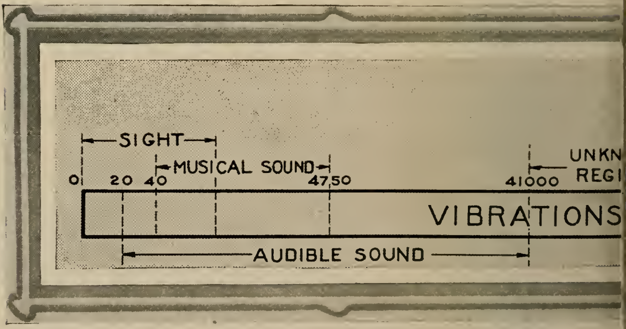


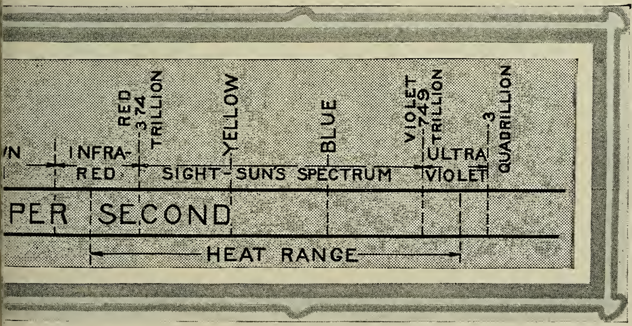
FIG. 2—Diagram showing the effect of Vibration to

was found that they fitted exactly into all the characteristics prophesied for them.

The proof of the assumption or prophecy became so certain that scientists ventured to name these unknowns and describe them in advance by their discovery.

Radium fell a victim to this seemingly uncanny prophecy. The blank lines reserved for radium were found to slightly indicate in pitchblend, carnotite and other uranium minerals. The indication was so slight, however, as to lead scientists to assume that the percentage of radium in these substances was very minute.

The Curries after pursuing the elusive element with exceeding patience and painstaking care, succeeded at last in isolating a very small particle. They were then in a position to study it by itself, weigh it, and test it before a spectroscope.. They found its spectrum line to fall in the heretofore blank space reserved for radium. They found its atomic weight to correspond to that assigned to radium, hence, there was nothing to do but call it radium.



produce the phenomena of sound, heat, and light

Color Study Interesting and Profitable

This study of the sun's spectrum has led scientists to discover and record many important and interesting facts. Principal among these facts is the existence of only three primary colors; red, yellow and blue—all the other colors present in the sun's spectrum can be reproduced by blending and mixing these three primary colors in different proportions. The reason for this simple and well-known fact is not generally understood.

Light is the result of vibration exactly the same as sound. If a piano string is plucked, or struck, a sound is produced, and with the larger piano strings the wave motion of the string, which produces the sound, can be seen. This wave motion is the important factor and its length and speed of vibration determines the pitch or tone of the sound produced.

Now, take the simplest form of wave motion,—a rope slackly hung between two posts. If it is struck, a wave will be seen to travel the length of the rope, and it is important to note that while the wave travels from one post to the other, the rope does not move in the direction of travel of the wave. A chosen spot merely travels up and down. It will also be noted that when the wave reaches a post, it gives the post a jerk and then bounces back on the return trip. This bouncing back can be likened to the echo of sound. While the wave motion of the rope can be seen, it cannot be heard unless the rope is stretched very tight. As the rope is gradually tightened, it will be seen that the wave travels more rapidly and the amplitude of the wave decreases. Finally, if the tightening is continued sufficiently, a sound will be heard, though of very low pitch.

Now, if we proceed to the bass strings of a piano

we will note that we can plainly see their vibration and hear a very low tone. As we proceed up the keyboard, it will be seen that, as the pitch raises, we are less and less able to see the string vibration, or wave motion, until we reach a tone where the vibration is so small and rapid that the eye cannot detect, though it is possible to feel and stop it with the finger.

The highest pitched strings on the piano possess an exceedingly rapid wave motion, and should we continue above and beyond the range of the piano, the tone would become a mere squeak and further advance would bring us to vibrations or wave speeds too rapid to be recorded by the human ear.

In order to produce an audible sound the vibrations must occur at a speed from 16 to 20 per sec. Tones of musical instruments range from 40 vibrations per second to about 4750 per second. Tones of higher pitch are shrill, and at an upper limit, varying with the hearer, they become inaudible at from 12,000 to 41,000 vibrations per second.

Sound waves may exhibit reflection, refraction, dispersion and interference; all of which properties are likewise true of light.

The sound produced by vibrations within the range mentioned above (from 20 to 41,000 per second, the limits of the human ear) is propagated by progressive longitudinal vibratory disturbances (sound waves), each including an area of condensation and rarefaction. These vibratory disturbances impinge upon the ear drum and are in turn transmitted to the auditory nerve.

The waves of sound as thus defined have all the properties of a wave on a pool of water caused by a falling stone. The intensity of the sound varies directly

as the square of the amplitude of the vibrations and inversely as the square of the distance from the sounding body. In dry air at freezing temperature it travels about 1087 feet per second.

Relation Between Sound and Light

We have seen that vibrations above 41,000 per second are inaudible. If the vibration speed is still further increased, a point is reached at about 374 trillion vibrations per second, where the vibratory disturbances, or waves, give the sensation of light to the human eye and we creep into the spectrum at the red end. From this point upward the increase of vibration speed carries us through the spectrum toward the violet.

Through the vibration speed range, covering the spectrum, the effect upon the eye can be very closely compared to the effect of the sound-range upon the ear. It might almost be safely said that the *eye hears the sound of the light.*

Further increase of vibration speed, beyond that which gives the violet of the spectrum, produces what are called ultra-violet rays. While these rays fail to produce the sensation of light upon the human eye, yet they will affect photographic plates, sensitized with silver chlorides, when quartz lenses are used. This latter fact was first discovered by one Scheele in 1777, but not thoroughly proven until about 1874.

The known fact that light and heat go hand in hand, caused it to be proven that heat is produced

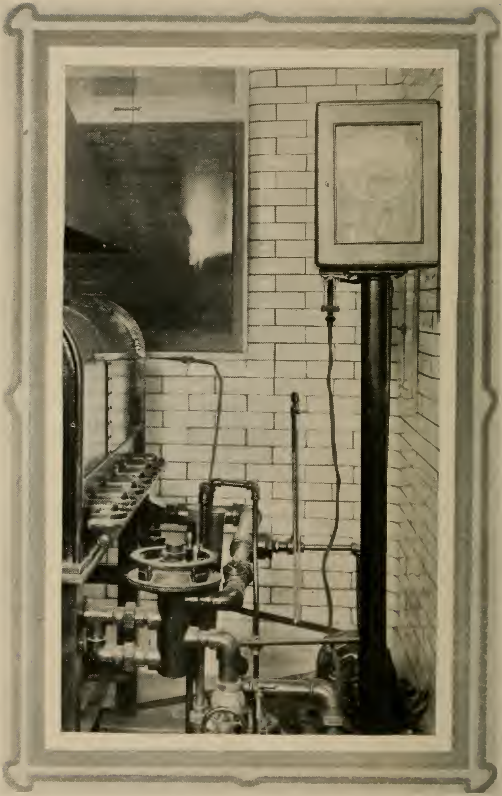
by the same vibration speeds as light, though the vibration-range of heat extends a little beyond both ends of the spectrum's vibration-range. These facts recapitulated show that sound, light and heat all have their origin in vibration and a map or scale of vibration speeds discloses some interesting facts. See Fig. 2.

Increase in speed of vibration beyond the scale shown in Fig. 2 carries us into the phenomena of electrical and molecular vibrations which science is rapidly proving to be definitely related to sound, light and heat.

To return to the spectrum and the study of colors,—the proof of there being only three primary colors, red, yellow and blue, takes us into the field of optics, a study of the human eye.

The structure of the human eye with its focusing lens and sensitive plate, or retina, is well known. The retina which transmits the record to the optic nerve, and thence to the brain, is covered with a growth of fine hair-like projections which are set in sympathetic vibration by the light waves after passing through the crystalline lens. Science has shown that these hair-like projections are divided into three kinds, uniformly spread over the retina. One of these kinds will only vibrate in sympathy with the wave length of a red ray; one kind with a blue ray, and one kind with a yellow ray.

Now, if a mixture of red and yellow rays comes through the lens of the eye, the hair-like projections corresponding will be set in vibration and the color sensation of orange will be transmitted to the brain. If there are more red rays than yellow, the eye will record a reddish orange, and if there are more yellow rays than red, the eye will record a yellowish orange, due to the fact that the hair-like projections are set in vibration in proportion to the amount they are excited by their



Oil furnace in the Laboratory of The Perfection Spring Company, showing automatic means of heat control

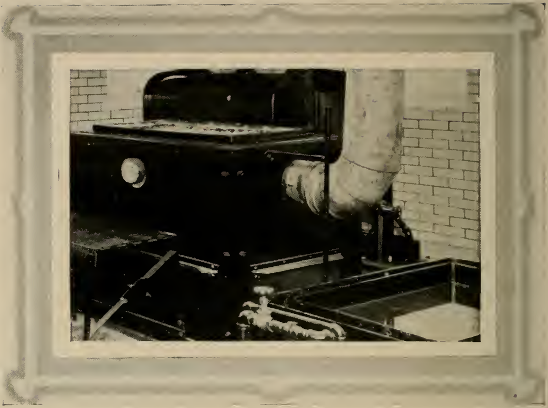
own particular ray. This fact explains the phenomena of the shaded and over-lapped colors of the spectrum, and is further proven by the fact that any of the shades of spectrum can be reproduced by mixing red, yellow and blue paints.

Color Absorption Clearly Defined

The next phenomena of interest to be noted and explained is that of color absorption. A transparent tube filled with a red liquid will not emit red light in a dark room; but, if exposed to sunlight, appears red, because all but the red rays are absorbed and the red rays alone reach the eye. If the liquid is green it is because all but the yellow and blue rays are absorbed. This peculiar but well defined phenomena of absorption explains why the color of certain liquids is changed by exposure to sunlight. The absorbed rays impart their activity to the molecular structure of the liquid, and if the structure is unstable, it yields to the attack and is changed thereby, thus altering the liquid's power of light absorption. Another way is to consider all the absorbed rays as being quite active and tending to force their way past all obstacles.

If the liquid is opaque, it means that the composition is such that no rays are able to penetrate; and if the liquid is clear and colorless, it means that no obstruction is offered and all the rays pass through.

Reflection of light and color follows similar laws. A red surface gives the impression of red, because it absorbs all but, and reflects only the red rays, etc. A surface appears black because it is so constituted that it absorbs all the color rays; a surface appears white because it absorbs none and reflects all the color rays.



Salt bath, with quenching pan, in the Laboratory of The Perfection Spring Company

A knowledge of these facts has led to great development in the arts, especially the manufacture, mixing and application of dyes and paints. A pigment or a dye is said to be "fast," when it is of such a nature that it resists the attack of the light rays it absorbs, and remains unchanged.

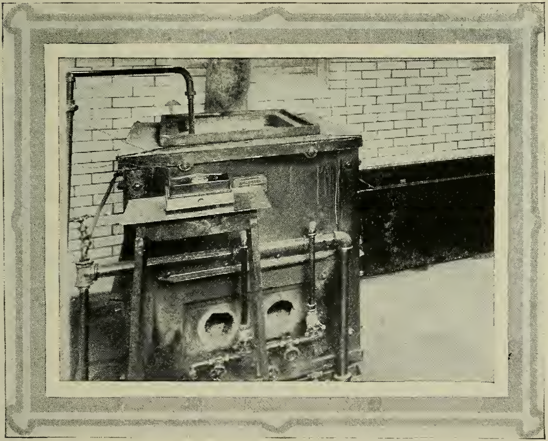
Body Finisher Profits With Others

If the molecular structure of the pigment is unstable the absorbed rays attack the molecules and cause them to take new forms, causing the pigment to have different color-absorbing power. The activities of the rays cause some of them to burst through and the eye records the

sensation of a new color. It naturally follows that the more intense the sunlight, the more active are the rays and the more likelihood of a change of color.

Transparent varnishes serve as a shield to protect the paint from the attack of the sun's rays by reflecting some of the rays. This reflection from the varnish explains why a coat of varnish always gives the paint underneath a lighter color.

Color varnishes, used to a large extent in motor car painting, are manufactured by mixing the pigment directly with the varnish, and, in that manner affording each molecule of the pigment a protecting, wax-like coat to assist it in combating the activity of the sun's rays. Again we find, for the same reason mentioned before,



Salt bath fitted with Master Pyrometer, in the Laboratory of The Perfection Spring Company

the color varnish is lighter in color than the pigment used.

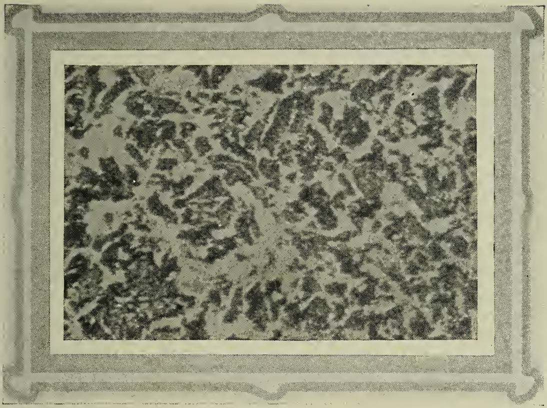
Vagrant Colors Impounded

Painters, expert in their art, always let their final colors and varnishes set, or dry, in a dark room so as to give the varnish a chance to become thoroughly dry before exposing it to the pitiless sunlight.

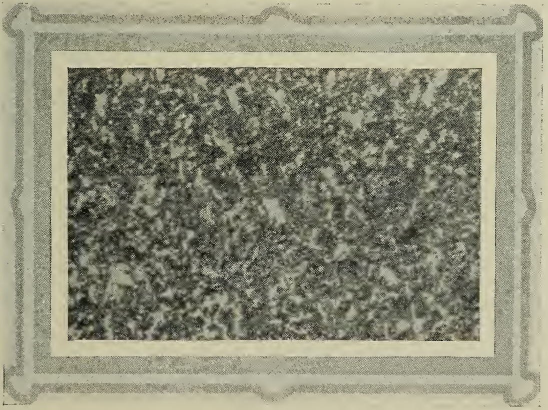
Micrograph of high carbon forging before annealing

It is obvious, from the preceding, that colors of motor-car bodies are difficult to maintain due to the very nature of vibrations which make them indicate as colors.

There is another very important series of damaging



Micrograph showing the effect of annealing upon the forging pictured on preceeding page



Micrograph of oil-quenched and tempered forging pictured on preceeding page

Electric furnaces for ascertaining recalescence and decalascence of steel, in the Laboratory of The Perfection Spring Company

influences brought to bear, which call upon the painter to exercise the utmost skill and care. These are the dangers that creep up from behind, as it were.

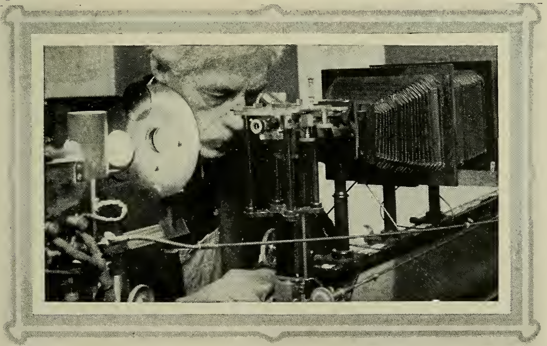
For a long time wood has been used for motor-car bodies for lack of more suitable material. Since wood is invariably porous, the filler and paint fabrics sink in differently and many coats are required, with careful "rubbing-down" operations between, to produce a smooth, even foundation for the colors. All of this careful labor is defeated, however, if the wood itself is not absolutely dry. If it is not dry, before the finishing work is started, it will check and crack as it does dry out. Such cracks will break through all the coats of color and varnish, and permit moisture and other damaging substances to get underneath the primer and ruin the foundation in the neighborhood of the crack.

Sheet metals are now extensively used and, while

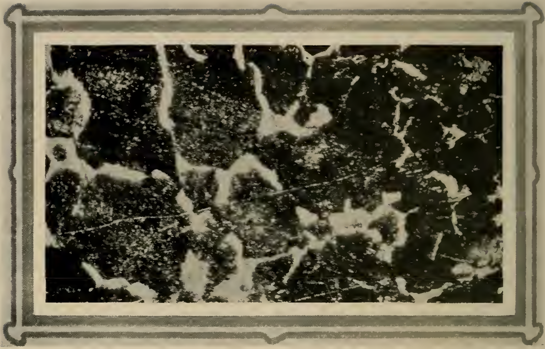
they offer a relatively smooth surface, there are other difficulties to be found that are not present in wood. To begin with, the sheet metal is not porous enough to offer any anchorage for the paint, making it necessary to prepare the surface and apply special primers in advance of the paints.

On sheet steel especially, the preparation of the surface, before applying a primer, requires that the surfaces be sand-blasted and the removal of even the minutest particles of rust. The presence of the least bit of rust is dangerous, as this oxide spreads along the surface of the metal and undermines the foundation of the paint, until a premature destruction of the paint fabric and even the metal itself, occurs.

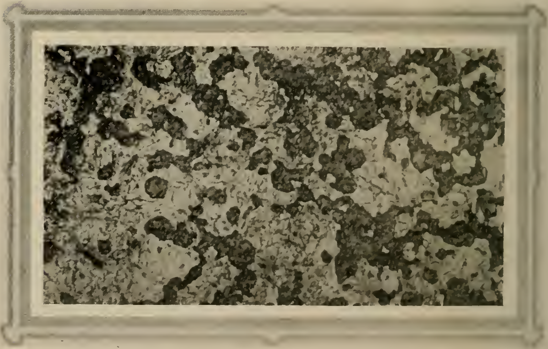
Acid pickling of the surface is sometimes employed, but great care must be exerted to neutralize the acid after it has removed the rust, mill-scale, etc., or the pickling process will continue after the paint is applied.



Laboratory Chief Professor Z. B. Leonard operating Leitz micro-photographic outfit for metallurgical investigations, in the Laboratory of The Perfection Spring Company



Micrograph of 90 carbon spring steel in the annealed state



Micrograph of 90 carbon spring steel in the hardened state

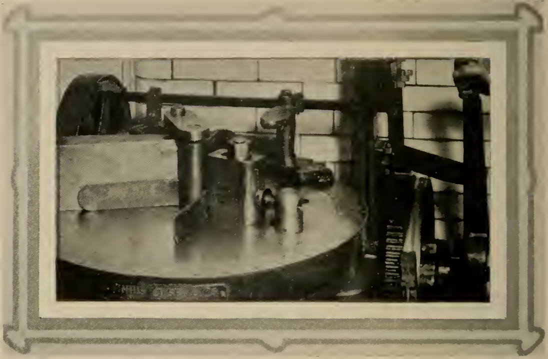
So much and more for the care to be exercised by the finisher. The owner of the car must observe certain rules to keep his paint colors in good condition after the finisher has done his share.

The final coat of varnish is applied, as described, to afford protection to the pigments. It also serves to keep out foreign matters that would tend to mud up the colors.

Mud, water, tar, dust and many other road substances, tend to attack and destroy the protecting armor of varnish.

Grease, oil and other solvents off of workman's clothing will attack the varnish. Accumulations of all such impurities must be promptly removed; and an occasional coat of fresh varnish applied by a skillful finisher will serve to protect the color pigments and preserve their tone and original beauty.

Micrograph of 90 carbon spring steel in the drawn state



Olsen cold-bend testing machine in the Laboratory of The Perfection Spring Company

Removal of Stains and Grease

AUTOMOBILING is a clean and healthy enterprise. It brings color to the cheeks of the delicate; vim to the man who may have parted company with his business vigor; pleasure to the child of the wanderlust, and the color of poetry to the lady of the romantic mind. But soiled garments may be the incident of the occasion. Unfortunately, too, axle grease is a most persistent character of product. It resists almost every effort to loosen it from its perch, as it is braced in the interstices of a weave.

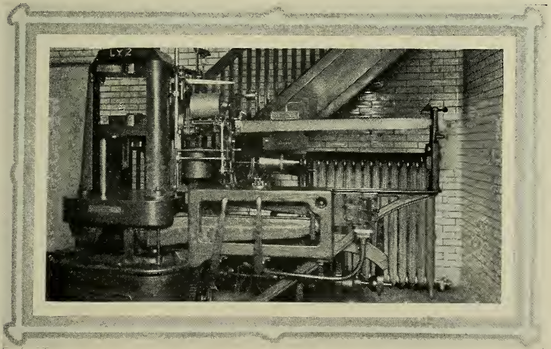
The best plan of attack, to renovate a stained garment, if the stain is due to wagon grease, is to apply solvents, according to the character of the fabric, as follows:

Linen:—Make a lather of soap with the goods, then apply oil of turpentine, then wash in a stream of warm water. Repeat, if necessary.

Silk:—Make a lather of soap in the goods, apply benzine (not benzene) then apply a stream of water, using some force, or, let the water fall from a height.

Cotton (colored):—Rub the fabric with lard; then soap it well. Let the goods stand for an hour, and thereafter alternate washes of water under pressure, and turpentine.

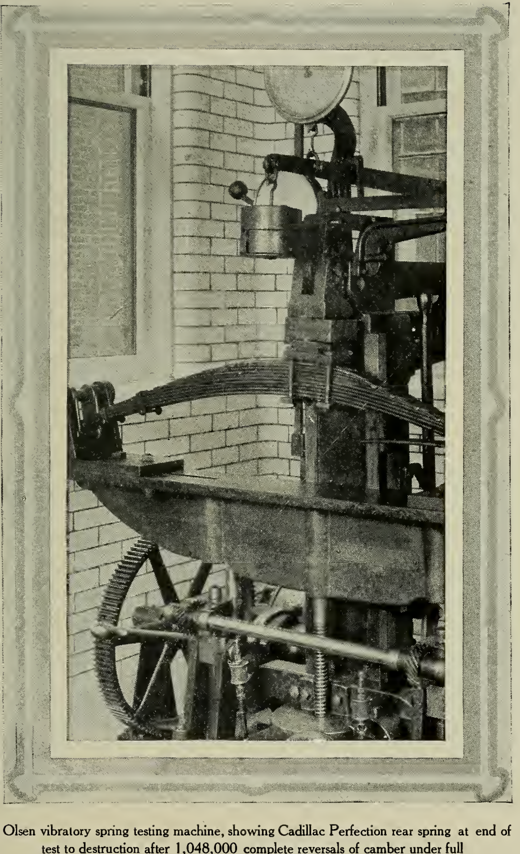
Woolens (colored):—Rub the fabric with lard; then apply soap to develop a good lather. Let the goods stand for some time. Wash with warm water under pressure, and in turpentine. If the grease still resists, repeat the water and turpentine treatment.



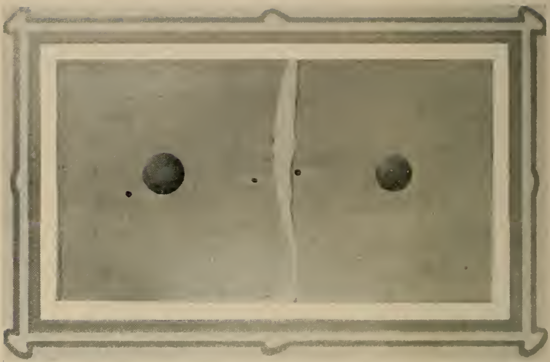
Olsen tension testing machine (capacity 100,000 pounds) with autographic means for recording elastic limit and tensile strength of materials, in the Laboratory of The Perfection Spring Company

THE IDEAL AUTOMOBILE

REFERRING to the ideal automobile, when Victor Hugo pictured Quisimodo's soul, he extended his language to include other hunch-backs as well. At all events, as Hugo said:— "Could we sound the depths of that misshapen soul; could we hold a torch behind those non-transparent organs, explore the dark interior of that opaque being, illumine its obscure corners, its absurd blind alleys, and cast strong light suddenly upon the Psyche imprisoned at the bottom of the well, we should doubtless find the poor thing in some constrained attitude, stunted and rickety, like those prisoners under the leads of Venice, who grew old bent double in a stone coffer too short and too low for them to either lie down or stand up."



Olsen vibratory spring testing machine, showing Cadillac Perfection rear spring at end of test to destruction after 1,048,000 complete reversals of camber under full load, in Laboratory of The Perfection Spring Company



In the hardness testing of springs, by the Brinell method as conducted at the Krupp plant at Essen, on the Steel used by The Perfection Spring Company

Cleansing the Oil Necessary

ON MOTORS employing a circulating lubrication system it is necessary to strain the oil at least once in its journey through the system. Chips, sand, and gritty carbon, of sufficient size to cause bearing-damage, are carried along with the oil and, where the oil is pumped directly into main bearings or, through a hollow crankshaft, such foreign substances would be delivered to the most dangerous point possible. Hence, the straining is an absolute necessity.

Strainers are usually placed on the suction side of oil pumps, particularly when a ball check pump is employed. Unless a strainer in such a location is of large capacity—stoppage is liable to occur (as the suction of most pumps is weak) as much foreign matter is present.

The pressure possibilities on the discharge side of a pump are much greater, however, and strainers placed on the discharge side can be of more dense material consequently giving more efficient filtration.

AT high speeds an oil film is practically continuous and keeps the surfaces quite apart. Such wear as then occurs must result from the presence of solid particles larger in diameter than the thickness of the lubricating film. Since the thickness of an oil film under pressure is very small (less than one one-thousandth of an inch) it is apparent that a very small particle of foreign matter will be sufficient to bridge the space between the surfaces and cause wear. It is obvious that the lubricant must be freed from all such foreign substances, especially if the substance is gritty.

In chemical Laboratory of The Perfection Spring Company, depicting Johnson apparatus for determining carbon contents in steel

Microbe Lamp May Come Next

WHILE practitioners squabble about the best method of lighting the way for automobiles, the world advances. A piece of tainted meat may ultimately supplant the electric light, the acetylene illuminator and the oil lamp. The living lamp is a laboratory reality to-day. From the laboratory to practice is only a step. That it will be cheaper to enslave a few hundred million lighting germs for a lamp than to operate an electric generator or an acetylene tank is the question.

From all accounts the first practical microbe lamp was made in a laboratory at Prague, the result of research and effort on the part of Professor Molisch. At all events, from the remotest time, men have been attracted by the firefly—not a few of them were of the opinion that a swarm of these little insects would suffice for a good-sized lamp. However, luminescent microbes make dead fish shine in the night. The same microbes feed upon tainted meat, and the phosphorescent glare observed in darkness is given off by the microbes feeding upon the meat, and not by the meat, as so many have surmised. These microscopic bacteria may be propagated in jelly. Professor Molisch first succeeded in developing a large colony of microscopic lighting bugs by feeding a nucleus upon "peptone," putting the same in gelatine—the peptone served as the nourishing property for the bacteria.

The nucleus of microscopic luminescent bacteria was transferred from dead fish to the peptonized gelatine. Maintaining a uniform temperature at the proper level for a sufficient time resulted in countless millions of these bacteria. The bacteria being provided with plenty of suitable food, multiplied at a surprising rate, waxed fat, as it were, and, to the delight of the observer, ex-

hibited a high degree of luminescence. It was a simple thing to transfer a batch of bottled-up bacteria to a lamp-holder and, by means of a reflector, intensify the illumination to a degree which made it easily possible to read a newspaper in the glare of the concentrated light-rays afforded; even photographs were taken, using just such a microbe lamp for the source of light.

Investigation in this interesting field is bringing a great number of new situations to the surface. It has already been discovered that there are a number of species of luminescent microbes. It has even been known that these microbes are of the most common kind floating around in the air. .When a piece of meat suspended from a hook in a butcher's shop is in its early stages of decomposition, if it is taken into a dark room it will in all probability, glow. The luminescent bacteria producing the glow are of one specie or another commonly floating around in the air, some of which, lighting on the meat, multiply under favorable conditions, taking nourishment from the meat.

It is of interest to note that the luminescent bacteria which inhabit meat in a butcher's shop is of the specie that furnishes the greatest amount of lumination; in a word, the best illuminating possibilities from a commercial point of view. Those who purpose experimenting upon luminescent microbes for lighting purposes will be aided in their research efforts to a material extent if they will be guided by experience. It has been found that the taint of meat is not due to luminescent bacteria. Indeed, it is a little difficult to find specimens of luminescent bacteria in tainted meat. The taint is probably due to a mixed infection. Persistent research rewards the scientist. In the course of events he discovers the illuminating bacteria in the meat. If the meat glows in the dark, that is the sure sign. However, the bacteria in question is so prevalent in the air that a scrap of beef,

if it is partly immersed in brine in a fairly cool room, will, after two or three days, begin to glow.

"Cultures" of light-giving bacteria of several species may be produced with a little care and attention, remembering that gelatine, peptonized, is the most efficacious medium of propagation of the bacteria. Experiment will soon enable the investigator to distinguish between the several species of the bacteria, since the candle-power per million of bacteria will differ. As before stated, while it is true that illuminating bacteria of dead fish glow considerably, they cannot hold a candle to the glow of the species found on beef in the butcher's shop.

Microbes Yield Unfailing Illumination

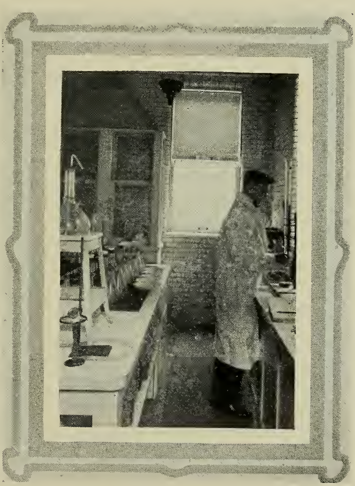
Persistence is one of the virtues of a colony of luminescent bacteria. The glow will continue with perfect steadiness for several weeks after the colony is "fattened." The living lamp, for such it may be called, is a simple contrivance. Granting that there is much, as yet, to be learned about living lamps, the fact remains that a fairly efficient lamp may now be made.

In order to produce a living lamp of considerable lighting ability, according to the best information, it will be well to pay strict attention to the purity of the luminescent bacteria to be multiplied. With a pure "culture," if the gelatine is of good quality, it remains merely to plant the culture in the prepared gelatine, which is rendered fit by adding the peptone and, as has been found to advantage in this type of effort, a little salt. For some reason the germs thrive best when salt is present in the feed. Let the "culture" develop—the glow, that is to say, the intensity of illumination, will be the best evidence of the condition of the colony.

When the "culture" is ripe, which will be shown by the candle-power of the mass, it remains to select a thin glass tube of good quality closed at one end and, after sterilizing the tube to get rid of all germ life except for the glow-germs in the gelatine, place enough of the gelatine in the tube to construct a thin film all over its inner surface, letting the excess of gelatine drip out, and then seal the open end of the tube.

Still another way (and, probably the best prospect), is to prepare the gelatine as above, place it in the sterilized tube to form a thin film and, then, with a sterilized platinum needle, "infect" the gelatine with the microbes, taking them from a specimen of glowing beef.

It will be understood that a stray microbe from some other family of bacteria will set up housekeeping in opposition to the illuminating culture and, if the intruder happens to be of a persistent tribe with strong constitution, a fester will develop to the exclusion of the "glow."



In chemical Laboratory of the The Perfection Spring Company, presenting Dr. Townsend delving into the mysteries of materials

The "infection" will spread all over the gelatine in the tube, due to the rapid multiplication of the germs in a field so favorable to their existence. It will take about forty-eight hours for the "infected" tube to reach full glow—this is a fair indication of the rate at which the germs multiply under favorable circumstances.

The Theory of the Living Lamp

"Photogen" is the name given to the protoplasms which are the cause of luminescence of rotten fish, tainted meat, and decaying vegetation—also for the light of fireflies, and other light-giving insects. Even the accumulations of glowing vegetation over the surface and on the bottom of the ocean, get their luminescence from this substance. "Photogen" has not, as yet, made itself wholly known to the scientist. The time was when "phosphorescence" was the only name by which the phenomenon was designated.

In the firefly, and, for that matter, in all life offering luminescence, it has been found that there is a considerable mass of structure composed of cells, each of which contains its speck of "photogen"—each microscope cell has its lantern, as it were. Scientists, in order to prove that the "photogen" was in the nature of a colony of microbes, rather than a condition of life of the original mass, removed the luminescent parts from various of these subjects, and, in each instance, after drying and pulverizing the mass, it was invariably found that the luminescence persisted for months at a time—for months, in fine, after the cells were dead. But, it was found that, upon dampening the mass of dried powder with a drop of water, the glow increased; this proves that the glow comes from microbe-clusters, and that they, the microbes, in order to survive, have to be nourished.

Luminescent protozoa, as they are frequently called,

abound on the surface of the seas and oceans all over the world. Because of the abundance of these mere microscopic animalcules lighting up the waters in colors of green and gold on summer's seas, especially in the tropics, it was easy to suspect that, since it is in salt water that the phosphorescent phenomenon is observed, that salt in the gelatine, along with the peptone, is nourishment for the light-giving microbes of the living lamp which promises to supplant electricity in the lighting of automobiles and for other purposes ere progress fetches up on the end of its rope.

Ten Pertinent Suggestions

1. Fill the gasoline tank with gasoline.
2. Fill the lubricating oil reservoir with lubricating oil.
3. Fill the radiator with clean water.
4. Adjust the spark lever to the "late" position for safe cranking of the motor.
5. Open the throttle a few notches in order to deliver a rich mixture for starting the motor.
6. Observe that the change-gear lever is in the neutral position.
7. Throw electric switch to "battery"—or to "magneto" if "battery" is not working.
8. If necessary, "prime" the motor by "flooding" the carburetor.
9. Engage starting crank by pushing it in direction of motor.
10. Give quick pull up on starting crank, using left hand, and "spin" motor if necessary—never crank with right hand, or push down on crank.

Tires Contract Microbe Disorders

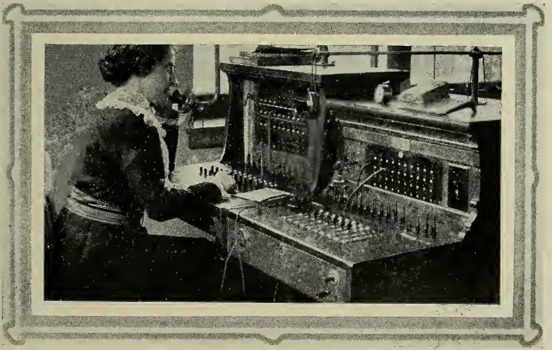
SURGERY, when applied to rubber tires is a sure cure for the disorders that attack them. Like hospital attention to the ills of man, if the necessary surgical operations are put off, even for a day, the malady will make such inroads that the patient will ever after live in a state of delicate health, assuming that the attack may not prove fatal.

A great variety of mushroom growths have fondness for cotton, of which the fabric of the casings of tires is made. These growths belong to the family of mildew; a growth of minute powdery or webby fungi. These fungi are whitish, or vari-colored. They perpetuate in the carcasses of decaying vegetation. In fine, these fungi are feeding upon the vegetation when it is said to be undergoing decay.

In plant No. 2 of The Perfection Spring Company, showing operator in charge of Master Pyrometer Signal System

In order to thwart the designs of the millions of fungi which are to be found in every pool of water by the roadside, it is necessary to prevent them from getting their teeth into the fabric of the tires. This is easily done. The plan is to heal every little wound as soon as it appears on the surface of the tires. The coating of "gum", made from the latex of the rubber tree, hardened and toughened by suitable applications of curing substances, as sulphur and other compounds, is proof against the burglars among mildew fungi.

The rubber of the tire performs several functions, but none are more important than the one of warding off mildew. Tire-surgery, under the circumstances, is a very important profession. Promptness is more than half of the battle. Seal up the wounds before the mildew penetrates the fabric. Seal them out; not in.



In plant No. 2 of The Perfection Spring Company, private telephone exchange, connecting all plants and departments

KNOW YOUR AUTOMOBILE

IGNORANCE of mechanism is no excuse for lack of knowledge of your car. You must know that, when you requisition the services of a repair-man, he will charge you just the same rate per hour for his ten hours of service looking for the trouble as he will for the one hour of work.

It is too much to expect of a repairer that he will know all about every make of car. It is all very well to rely upon a medical practitioner to locate a "cyst" in the human machine—they are all much the same. Conditions differ in automobiles—get acquainted with the mechanism of your car. Tell the repairer just what you want to accomplish. Confine his effort to the work to be done. If he evinces a desire to rummage around looking for other possible troubles, tell him to make the excursion at his own cost and expense—he will lose interest after that.

The Laboratory Eliminates Chance

THE growing relation between theory and fact has been paralleled by the close union between laboratory and factory. The laboratory determines and codifies the methods to be employed in fabricating the materials of construction into commercial units.

The science of metallurgy has shown that commercial steels show wide variation as to chemical analysis, physical properties and molecular structure. It has also taught that, in order to intelligently handle a given steel, chemical, physical and molecular properties must be known in advance. This brings into demand a laboratory properly equipped to record these properties.

Realizing that success lies along the line of knowledge, The Perfection Spring Company possesses a laboratory completely equipped to supply the knowledge required. Means are at hand to determine with great rapidity and accuracy, the chemical components of any commercial steel. The accurate Johnson apparatus is employed for carbon determination. All orders for steel contain a specification of chemical analysis with permissible limits of variation. Before a given shipment of steel is formally accepted and allowed to enter the plant, samples are taken at random and the chemical analyses thereof compared with the specification incorporated in the order for that particular lot of steel. This method reduces to a minimum the possibility of any undesirable material getting into work.

The fact remains, however, that in two pieces of steel of identical chemical analysis, there may be wide

differences in physical properties as a result of the steel making. Independent of chemical analysis, there are seven items that have a bearing on the quality of the steel before it enters the spring plant.

(1) The purity of the ores.

(2) The clever blending of the ores and "scrap" when preparing to produce a desired steel.

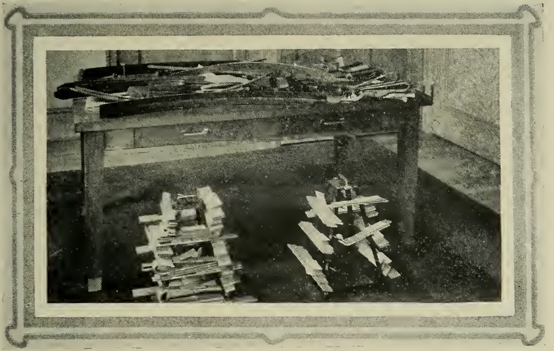
(3) The weight of the charge presented to the refining furnace.

(4) The type of furnace employed in the refining process. There are five types of refining furnaces now in use, all producing different qualities of steel regardless of chemical analysis.

(a) Bessemer.

(b) Basic Open Hearth.

Mr. Christian Girl, founder and President of The Perfection Spring Company, at his desk



In office of President Christian Girl cf The Perfection Spring Company, presenting Laboratory Specimens of the company's product

(c) Acid Open Hearth.
(d) Crucible.
(e) Electric.

The Bessemer furnace makes cheap steel possible but gives low quality, owing to the trapping of gases and other causes. The basic open hearth is better as it permits the escape of the gases and the reduction of the metalloids. If sulphur and phosphorous are present in the ores to an undesirable extent, it is possible to reduce them in this process.

The crucible furnace calls for the handling of the ores in small quantities and with great accuracy, but is quite expensive. The electric furnace method is best of all as it removes the gases to a very high degree by virtue of the electrolytic action. The electric method is extremely expensive, placing an almost

prohibitive price on its product. This difficulty has been partly overcome, however, by first using the basic open hearth to reduce the metalloids and then using the electric furnace to further refine and remove the gases.

(5) Billet inspection.
A proper chipping and cropping of billets removes "pipes" and seams.

(6) Fabrication at the rolling mill.
Best results are obtained by repeated rolling of the bars and continuing the rolling until the terminal temperature is correct. Careless mills pass the steel through the rolls a reduced number of times and cast it aside while the temperature is still high. Careful mills pass and repass the steel until exactly the proper terminal temperature is reached and no lower.

(7) Treatment. After the bars have been rolled they are annealed—an operation requiring a considerable measure of skill and care.

Due to this variation in quality, with a given chemical analysis, it is necessary to further guard against faulty steel getting into the plant. Specimens of an incoming lot of steel are subjected to a series of tests which disclose the physical state of the material.

Uses of the Micrograph

The microscopic-photograph or "micrograph" makes possible permanent photographic records of the carbide condition of the samples. To produce such records a Leitz microscope with photographic attachment (imported from Germany) is employed after the specimens are polished and etched.

Such micrographs immediately show up inherent imperfections, small blow-holes, caused by trapped gas bubbles; distribution of the carbide constituents, and other structural characteristics.

The Tension Test

Another sample, of known cross-section, is placed in an Olsen tension testing machine and broken; giving the elastic limit, tensile strength, elongation and reduction of area.

If the steel is chemically correct and has satisfactorily passed the above tests, in the annealed state as received from the steel mill, it is put through another series of tests having a bearing on and recording its performance when "heat-treated" in various ways.

Points of Recalescence and Decalescence

Before a specimen is subjected to heat treatment, its recalescent and decalescent periods are determined in small electric furnaces. In obtaining these most important critical points, a pyrometer of the greatest exactitude and sensitiveness is employed. A determination of these critical points is absolutely necessary to intelligent treatment of the steel. The next step is to give several specimens different predetermined treatments in order to record the best.

The pyrometer plays a leading part in all subsequent work. Specimens are now taken to the heat-

treatment laboratory and heated in a gas-fired salts furnace. A delicate pyrometer automatically controls the fire in this furnace, so that an even predetermined temperature is maintained. When the specimens have arrived at the desired temperature and are thoroughly heated they are quenched (hardened) in a tank of oil.

When thoroughly cooled, they are "drawn" at desired temperatures in molten salt baths. Another pyrometer in the molten salt records its temperature.

Mr. P. A. Connolly, Secretary of The Perfection Spring Company, at his desk

The Fatigue Test

These specimens (marked according to the treatment they have received) are placed in a fatigue machine. This machine grips the specimen solid at one

end and bends the other back and forth until fracture occurs, the machine recording the number of bends required to break the specimen. This test promptly indicates which treatment gives the greatest life to the given steel.

Cold Bend Test

Before the treatment giving the best fatigue test

Perfection Spring Company, General Accounting Department, depicting light and airy offices

is adopted as the best all-around treatment, other treated specimens are given the cold bend test. Here they are bent about a pin until they break, when the degree of rotation is recorded. When a specimen is doubled on itself (180°) and does not break, it is allowed to recoil until free, when the degree of recoil is recorded.

Comparison of the fatigue and cold bend test results show which treatment gives the longest life commensurate with resiliency.

Some of the fractured specimens are now polished, etched and micrographed in the treated condition, for further examination to note the carbide condition.

The Plant Follows Suit

When a steel has passed all these exacting tests and is not found wanting, it is accepted and released for work. Before it passes very far a complete plate spring is made up and sent into the laboratory for a vibration test.

The Vibratory Test

This machine affords a rapid means to break the spring under approximate motor-car conditions. It is hung on the machine in exactly the same manner as on the car and loaded up to what it is designed to carry. It is then bent up and down under full load by the machine, through a fixed amplitude until it breaks. A counter records the number of strokes.

Uniform Results Follow

The compiled data of the preceding tests gives the plant an exact knowledge of steel it is handling and tells the temperatures required to give the best results.

In The Perfection Spring Plant No. 2 alone there are 38 heat treatment furnaces, each and every one of which is equipped with a pyrometer. These pyrometers are connected electrically to a common board where a master operator makes a record of the temperature of each furnace at definite intervals. This operator is enabled by an electric light system, to signal the operator of each furnace as to the correctness of the temperature he is maintaining.

Uniform Production the Keynote

As a further guaranty of uniform production, a completed spring is taken from time to time and placed on the vibratory machine. The results obtained are checked against the result of the first vibratory test, and any variation is promptly corrected.

Since all steel admitted to manufacture is tested for uniformity, it follows that a uniform product will result if uniform methods and treatment are pursued.

The unremitting vigilance of the laboratory and the co-operation between laboratory and factory can only spell one thing—advance.

The laboratory is constantly uncovering new information and the factory is constantly profiting thereby. All problems are solved in the laboratory by accurate and definite measurement.

When a new brand of steel is presented by a steel mill and extravagant claims made for it, the laboratory "frisks" the steel of its secrets. Records are made and if subsequent shipments do not measure up to the sample, it means that the mill is not capable of producing quantities up to the grade of samples.

Perfection Spring Company Factory Accounting and Cost Departments under efficient conditions

The Perfection Spring Company, by means of its laboratory is constantly investigating new steels and comparing them with familiar brands, in the constant quest for better material. The thin-leaf spring, made famous by The Perfection Spring Company was perfected in the laboratory because definite data was thus obtainable. Subsequent road experience ratified the earlier laboratory venture in this, as in hundreds of other examples no less conspicuous if not quite so spectacular.

Stenographic Department of The Perfection Spring Company, depicting a light and airy establishment

Just a Word About Spring-Making

WE HAVE been building springs for automobiles for seven years. We fashioned the first thin-leaf springs for automobile use—they have revolutionized spring suspension practice.

WE ARE specialists in the making of springs for automobiles, with two big plants devoted to spring making and to nothing else.

WE KNOW that our facilities are, by far, the most complete, and that our staff of engineers, metallurgists, spring engineers, chemists, and spring artisans, are the pick of the world.

WE ENJOY, and justly so, a reputation for the quality of our product which, if measured by compari-

son, places us so far in the lead that the traces must be cut in order to prevent the price of leather from going up and beyond the say-so of a mere pocket-book.

WE HOLD that the most valuable asset we possess is the reputation our springs have made and are making to-day. Moreover, we understand—we know—that our continued success depends upon the efficiency of the springs we build.

WE REALIZE that a great reputation must grow and expand or suffer contraction. We expect to continue to grow and expand. We make no secret of the formula—it is bounded by four reasons: They are (1) quality of material, (2) painstaking effort, (3) modern facilities and (4) broad business methods.

WE GATHER, from the growth of our business—which increased 66 per cent. last year—that we do not have to invent complicated reasons why our springs are the best. They just, plain, ordinary, are the best, because we intentionally make them of the best steel and, in the best way.

WE EXTEND to all, customers or not, the use of our chemical and physical laboratory, to help them solve their spring problems, just as we were enabled to solve our spring problems. The laboratory is modern and complete. Not a single necessary instrument, device, or fitting will be found missing.

WE INVITE our customers and our friends in the spring-making business to come and see our plants; see how we make springs, observe of the ways that will benefit them if they are desirous of making the best kind of springs or, of making the most efficient use of their springs.

WE STAND in the light of having no argument of any kind with our customers. Since our springs are right we get the benefit of repeat orders. Should we take any other course, it would be a reversal of the policy that has brought to us abundant success.

Materials for Motor Cars

VACUUM-TUBE investigations are rapidly leading up to a very clear understanding of the behavior of the molecules of matter, such as reside in the fluids used in motors, steel for parts, castings of cylinders, etc. However, nowhere is it possible to find license for the glib statements too often made that axles, for illustration, because of premature failure in service, do so on account of faithful service rendered, because of crystallization setting in. Crystallization is not an easily contracted disorder; it is more likely to obtain as an initial condition of the process of manufacture, brought on by unskilled heat-treatment work, or to be traced to a poor selection of material for a given undertaking.

At all events, education is the cure-all. No maker of automobiles will risk failure through selecting inferior material for a given responsibility, if he realizes that the material selected for the purpose will not do. No user of automobiles will risk his neck in a car—or his money in an investment—unless promise is in fair keeping with performance. In the meantime, few men take the time to unravel the tangle that Nature wrought in materials for motor-cars.

By way of proceeding, it may be well to observe that controversy gets in the way of progress. It is difficult to get men who do know, to tell what they know. It is easy to get men who do not know, to state what they think they know. Listeners are as liberal in one direction, as they are in another. They pay little or no attention to either side of a question. The average listener knows that there are only three lights: the sun, the moon, *and himself*.

In the meantime, progress makes for progress. The

vacuum-tube in the hands of the physicists, aided by suitable electrical instruments and auxiliaries, renders it feasible to identify the molecule of matter; its behavior is noted; its speed is determined and, in fine, *it is forced to weigh itself*. Considering the trifling weight of a molecule—something like the trillionth of a gram in certain examples—it is something to caliper. Nor is it less difficult to determine the speed of a molecule, viewing the subject in the ordinary way. Indeed, remembering that the speed of a molecule of ordinary air is not far from sixteen hundred feet a second in a free path, it presents no less difficulty than that experienced in measuring the speed of a bullet out of a rifle, remembering that neither can impress the eye of the hopeful observer.

But, the average man is willing to believe that there is such a thing as a bullet. He can examine and han-

Ladies Rest Room on second floor of the "Perfection" office building

dle it; put it into a gun; fire the gun, and, examine the hole made by the bullet where it strikes the target. Because the average man cannot pick up a molecule; toy with it; load it into a gun; fire the gun and, note the markings of the target, what does he say? Why, he says: "There ain't no such animal." However, it was over sixteen years ago when physicists captured the molecule and made it tell on itself.

Molecular investigations are conducted by means of vacuum-tubes. A vacuum-tube is usually made of glass closed up at both ends. The air is exhausted from the tube as perfectly as possible. It will be understood that the air cannot be completely removed from the tube. One end of the tube is provided with a fluorescent screen—let us call it a target. The opposite end of the tube is fitted with an electric connection, much as the wires that are led to an ordinary incandescent lamp. A suitable source of electrical energy is connected to the

Perfection Spring Company, Reception Room in lobby of the "Perfection" office building

tube. Instruments are provided for measuring the pressure, rate, and energy value of electrical energy supplied to the tube—necessarily, the instruments used are delicately wrought. A means is provided for applying electrical and magnetic forces of attraction and repulsion to the exterior of the tube. In the operation of the equipment, when the electrical current is turned on (much as an electric light is turned on), a stream of molecules travels the length of the tube in the direction of the target. What do they do? They hit the target. How is that fact noted? They hit the target so hard that they strike a light, just as a light is struck when two pieces of flint are forcibly brought into contact with each other. Moreover, since the molecules hit the target so hard that their mass is raised to incandescence, hence, show a light, it is reasonable to suppose that the target should be battered up by the shower of blows rained upon it by the stream of molecules. Expectation is realized. The target is marked where the molecules hit it!

Where do the molecules come from? They are of the air which is left in the vacuum-tube, or they may be added to the residual air, it being impossible to remove all of the air from the tube. What is the significance of the presented situation? Let us revert back to the first principles of gunnery for purposes of comparison. First, the point, at which a bullet fired out of a gun hits the target, depends upon the muzzle velocity of the bullet. Second, the momentum of the bullet influences the aim. And, third, the downward pull of gravity tends to direct the course of the bullet to the ground. If there is any atmospheric disturbance, as "wind," it must be invited to participation in the calculation. In the same way, when a stream of electrically charged molecules are projected at high velocity for the length of the tube, first, the point of impact of the molecules with the target depends upon the initial velocity of the molecules, just as if they were bullets. Second, the momen-

tum of the molecules must be determined. Third, the deflecting influence of a "false" gravitational effort must be observed. This "false" gravitational effort is made by means of an electrical or magnetic device situated closely to one side of the vacuum-tube. There being no "windage," this factor is neglected. Now, knowing the magnitudes of all of the extraneous forces, the mass of the molecule can be calculated. Since the molecules mark the target where they hit, what is more simple than to deflect the stream of molecules more or less by means of the "false" gravitational force, thereby making it possible to measure the amount of deflection. With this information at hand, knowing that the point at which the charged stream of molecules hit the target will vary according to speed; if the "false" gravitational force is increased or diminished, the marking upon the face of the target will be at a different point—the speed will change. The difference on the target may be measured; the force of the "false" gravitational effort may be determined; hence, from the known quantities, the unknown quantities may be calculated. Indeed, the position of the "splash" of the stream of molecules upon the fluorescent screen—the target—*almost tells the tale at a glance.*

Molecules "Frisked" for Secrets

It has been ascertained that molecules traverse an oscillatory path, normally accelerating to as high as eighty miles a second. In the vacuum-tube, it may be interesting to observe, that the electrically charged molecule under favorable conditions, reaches the terrific speed of one hundred thousand miles a second. At anything like this speed, when the molecules hit the fluorescent screen at the opposite end of the vacuum-tube, the force of the impact is so great that the molecules are heated to incandescence—they glow; the appearance is that of dazzling specks of light.

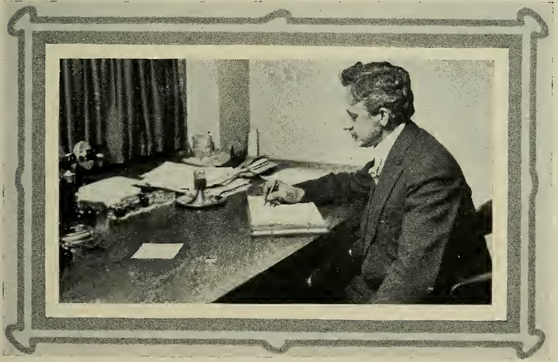
From reports emanating from the Cavendish Laboratory and from other sources by way of corroboration, we learn that the molecules of all bodies are in motion —they are never without motion. We are told that, in gases, there is nothing to prevent the molecules from passing from any part of the mass to any other part; in liquids, if there is any impediment, to the free passage of the molecules, it is a mere tendency, rather than a pronounced realization; in solids, however, it is a molecular diffusion, rather than a free passage of the molecules, to which we must pin our faith.

We are exptected to believe, in relation to the free passage of the molecule, referring to gases, that, for common air, its molecule is moving in its free path at the rate of sixteen hundred feet a second. However, a molecule of hydrogen moves at the rate of a mile (5,280 feet) in a second. Referring to liquids, the passage of the

Comfortable quarters of Assistant Manager W. E. Perrine, of The Perfection Spring Company, Mr. Perrine present

molecule is at a far less rapid rate of speed. Even so, there is a constant transference of each individual particle from place to place throughout the mass. In solids the rate of transfer of the individual particles is reduced to a mere diffusion—some of the particles in the solids are slowed down to a simple oscillation; in other cases of solids, the molecules oscillate about a certain average position. Again, referring to solids, groups of molecules, aggregated to form regular systems, remain in much the same oscillating system—*me must look for the crystalline structure in these groups of solids.*

But the molecule of free air, travelling in its free path at the rate of sixteen hundred feet a second, does not long enjoy a free path before coming into collision with other molecules; it goes no more than one two-hundred-thousandth part of a second before it is deflected from its straight line of travel. Actual collision never takes place. Instead, the molecule makes a zig-



Mr. C. E. Clemens, Spring Engineer of The Perfection Spring Company at his work

zag journey; it changes its direction of travel nearly five thousand million times a second. In liquids the movement is less rapid but, as before stated, there is a constant transference of molecules. However, instead of measuring in millionths of a second, fractions of a day must be substituted for the completion of the cycle referring to the travel of the molecule in the liquid. Then, for the travel of the molecule in the solid, remembering that it is more in the nature of a diffusion, the time of the cycle must be measured in years, instead of days.

From information at hand it is to be inferred that the path of the molecule is zigzag; that the motion of the molecule is oscillatory, and that the speed of the molecule is greatly accelerated if that molecule is electrically charged. Again, the speed of the molecule is less and less as the mass of the matter under consideration is compacted. In a word, in a rarefied gas, as in a vacuum-tube, the speed of the molecule is enormous; destroying the vacuum, that is to say, letting in more air or gas, slows down the molecule. Were the gas compressed in the tube, the molecule would be retarded more, and, at a rate which would increase with the degree of compression. To carry the matter a little further; compressing the gas sufficiently, allowing the heat of compression to dissipate, would reduce the gas to a liquid. Then, as we have learned, the speed of the molecule would be greatly diminished in that liquid. And the compression might be carried on, let us say, until the liquid would ultimately solidify—it would freeze. What then? The speed of the molecule would be reduced to a very low rate of travel. Considering solids, then, what is the inference? Why, if the solids are compressed, the effect will be intensified; the speed of the molecule will be further reduced—and if the solid is finally compressed to the last word in density, it will be at the expense of speed of the molecule; if the molecule is so hedged in

by other molecules, if it has no place to go, its motion will then be in the nature of a mere quiver. However, before the molecule can be hedged in sufficiently to reduce its oscillations to a relatively speaking mere quiver, something else happens; the mass becomes so dense and hard that it partakes of brittleness—it fractures readily.

Let us have a second look at this phenomenon of molecular speed as it is referred to solids.

(a) We are bound to assume that the molecules of all bodies are in motion—and, if we are, then must we not also take it for granted that, if the molecular motion is dispersed, the clusters of the involved molecules will suffer disintegration?

(b) In proportion as the mass of a solid is compacted, so will the oscillations of the molecules of that solid be restricted and restrained.

(c) It is reasonable to suppose that the only way that a solid can be rendered more dense is by adding to the number of molecules per unit of volume of the mass—that is to say, by compacting the mass.

(d) If, by compacting the mass of a solid, the molecules per unit of volume can be augmented in number, explanation may then be made of the restriction placed upon the motion of the molecules—with an increased number of the molecules per unit of volume, the path of free travel of the individual molecule will be shorter and the zigzag course of the molecule will be more zigzag.

(e) Molecular motion can only be attended by a loss of energy; increasing the molecular energy-loss is a mere matter of making the zigzag course of the molecule more zigzag.

(f) From what has been said, the strength of a solid (as a specimen of steel) persists so long as the molecules of that mass are in motion—suppress molecular motion and the strength of the mass will fade out.

(g) But the only way to suppress molecular motion is to crowd such a large number of molecules into a given volume that there will remain too little space in which the molecules may oscillate.

(h) While it is not known how to utterly suppress molecular motion in a mass, even so, by a process of compacting and hardening steel, for instance, it may be rendered so dense that the molecular motion is so much restricted that the steel becomes brittle—*it loses its elongation.*

(i) Why does the specimen of hardened steel attain brittleness with hardness? Is it not because the molecu-

Sales office of The Perfection Spring Company. C. W. Hatch at his desk

lar bond is overcome because the molecular tension is dissipated—the energy is lost in successive accelerations of the molecule pursuing a zigzag course that is rendered more zigzag?

(j) However, if a mass is made up of a conglomeration of elements, which is true of steel, it is to be expected that the attending molecular conditions will differ in the respective elements as they relate to each other in the conglomerate. It is to be inferred that the process of compacting of the mass will result in a divergence of the ultimate results in proportion as the molecular conditions change in the respective elements of the conglomerate—some of the elements will compact easier than others, hence, some of the elements will retain their strength longer than the others.

(k) Since it is believable that all systems of molecules persist for the period for which they may be

Quarters of John G. Utz, of the Consulting Engineering Staff of The Perfection Spring Company

wound up, it is conceivable that all such systems must ultimately break up—*they must some day run down.*

(l) What is there in a "wound-up" system of molecules that cannot be fully explained by referring to them as energized molecules? If so, may we not conclude that, by adding to the store of energy of the molecules we may add equally to the strength of the mass of the molecules? In which event, what is plainer than that, by increasing the molecular energy-loss, the mass of the molecules may be brought nearer to disintegration?

(m) Systems of molecules may break up, partly on account of the frequency of the oscillations and, for the rest, depending upon the system of grouping. But, why should we refer at all to the strength of the mass of the molecules in a group of molecules? Would it not be more to the point to refer to the sustaining force of a cluster of energy reservoirs or vehicles (for want of a better name), imparting greater rigidity to that portion on the luminiferous ether in which they reside. In a word, since it is believable that the ether permeates all space, why is it not to the condition of the ether to which we refer at all times? If a zone of the ether is more intensively energized than the ether round about that zone, then is it not true of the energized portion of the ether that it will behave in a manner different from the surrounding ether which is not so intensively energized?

(n) Referring to the molecule in a somewhat different light, why is it not in the nature of things to be looked upon as a bubble of energy floating in the ether?

(o) We say of the earth (and all similar bodies) that it is a bubble raising in the ether. What is the earth? Is it not an aggregation of elements—a plurality of compounds? And, what are compounds? Are they

not made up of the elements? But, what are elements? Systems of molecules, to be sure. Then, let us ask ourselves the question? What are molecules? Must we not answer: *Bubbles raising in the ether?*

(p) Since it has been shown that systems of molecules, after they run down, disintegrate, does not that prove that a run-down system of molecules is merely one that has no plus potential? Very good, then, we have finally to admit that a molecule is a reservoir of energy—*a bubble of energy.*

(q) And, if a molecule is to be regarded as a bubble of energy floating in the ether, what must we say of a system of such bubbles of energy, referring to their combined capability for useful work? Why, if the bubbles are strung out too much, the strength of the whole will be absorbed between them in the process of main-

Purchasing Department of The Perfection Spring Company
presided over by A. E. Homan

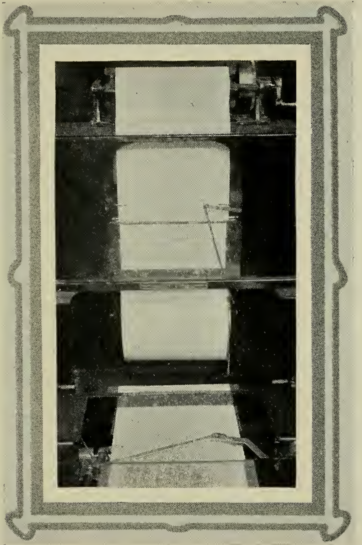
M. M. McIntyre, Superintendent of The Perfection Spring Company, in his office

taining the bond. Whereas, if the bubbles of energy are excessively compacted, there, again, is the cause of such great internal losses that over-much of useful work is scarcely to be expected. The free energy of the bubbles will be dissipated in a succession of accelerations to no purpose from the external work point of view.

(r) What is meant by external work in this discussion? Why, it refers to the ability of a system of groupings of molecules to withstand external applications of like forces. A beam, made of steel, for instance, offers an example of such a system and, in proportion as it is resistant, it measures its ability to perform external work. However, the very beam which is looked upon as normal is, in reality, a system (or a combination of systems) of molecules in motion, imparting rigidity to the luminiferous ether at a point of concentration as compared with the free ether.

Lubricating the Connecting Rod

IN the "big end" bearing of a gas engine connecting rod, the load is neither constant nor continuous in one direction, thus permitting the bearing surfaces to alternately approach and recede from each other. On such a bearing the alternation is very rapid and the bearing will carry a great weight, for at each alternation the pressure is completely relieved, and the oil trapped cannot be expelled during the short time the load rests on the bearing. In the wrist pin bearing even greater pressures per square inch can be carried, for the angular movement between the pin and bearing is alternating and relatively small.



Telautograph system used for inter-departmental communication by The Perfection Spring Company, making for silent and swift executive work

Christian Girl Answers Question

PEOPLE frequently ask the question:—How did you ever succeed in making your spring plant the largest and best known automobile spring-maker's plant in the world?

EVERY success must have its explanation. Every success has a common explanation, i.e., live up to an ideal. The ideal of The Perfection Spring Company is "PERFECTION."

REGARDING success. It may be just as well to point out that "perfection" begins with perfected material, passes on to exquisite skill in the fashioning of the component plates of the springs and, ends with integrity—business integrity.

FROM the first small beginning of this company a little over seven years ago down to to-day, no steel-maker has ever sold a bill of steel to the company that was not of the best—the first fabric of the mill—for spring making purposes.

EVERY process of spring making, from the receipt of the steel and the laboratory testing of the same before use, gets the careful attention and personal consideration of M. M. McIntyre, who, as every man skilled in the art knows, has a reputation spanning 40 years or more, as the Master Spring-maker of America. It is to this organization that the famous Krupp Company—the gun-makers of Germany, look for the proper handling of Krupp Silico-steel for springs, and it is in the plant of The Perfection Spring Company, that all Krupp springs are made for the American trade.

CENTURY-OLD steel makers, like Fried. Krupp, of Essen, Germany, are not the infants in business who would take any chance with incompetence or inexperience. In the meantime, the plant of The Perfection Spring Company has grown and expanded, until, to-day, it is, by far, the largest spring making plant in the world.

THERE is no better evidence of the sterling qualities of Perfection Springs than that afforded by the customers themselves. They would complain were the springs inferior—they have no complaint to make—they never will have ground for complaint.

ILLUSTRATIONS of great success may be found in every walk in life. The illustration of success in the automobile spring-making world, is The Perfection Spring Company.

OTHERS have tried to rival The Perfection Spring Company, but they didn't have Krupp steel; they didn't have Mr. McIntyre; they didn't have the Perfection Laboratory; they didn't have the facilities; they didn't stand back of their goods; they didn't have the goods to stand back of.

NOTHING can prevent The Perfection Spring Company from continuing in the future, as it has in the past, to make the very best springs for automobile use—nothing but disregard and stupidity. But, since it was the reverse of disregard and stupidity that made the Company what it is—the greatest spring-making plant in the world—it is useless to prophesy anything but success, not only for The Perfection Spring Company, but for all who use Perfection Springs.

Time clocks in plant No. 2 of The Perfection Spring Company

Don't Buy What You Can't Sell

THERE is only one sound rule for the prospective purchaser to observe—*don't buy what you can't sell.* If there is no market for a thing it is not a commodity — it is a drug on the market.

It is on account of the soundness of the above rule of purchase that the name-plate on an automobile is something to consider. An automobile which has a liquid value on the second-hand market, is worth more money at first-hand than a car that sheds its "liquid" with its lustre.

If you want to know the best car for your purpose. be sure that the car will serve your end; do your work; answer your requirement—then look at the price-tag; glance at the second-hand market; note the "liquifying" possibilities and, on top of every other consideration, remember: *don't buy what you can't sell.*

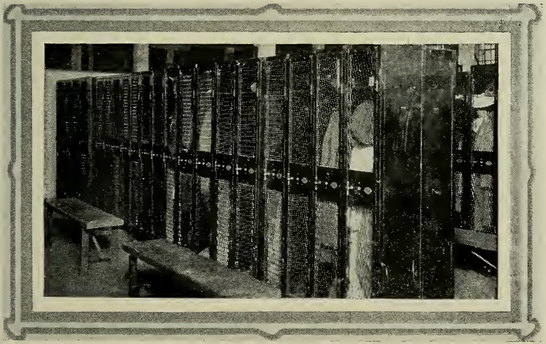
The Trend in Spring Making

HESIOD, the Greek Poet (about 700 B. C.), outlining in fable the early history of man, divided it into periods as follows:—

1. The *golden age,* taking the Old Testament as his basis, reflecting the nature of Paradise.

2. The *silver age,* depicting a secondary and mundane idea, tinctured by the troubles of turbulent man.

3. The *age of domination,* during which dissensions of the fierce, strong races reverted back to a state of savagery—and bronze weapons were contrived for the occasion. Let us add—



Individual lockers in separate room, available to the workman of The Perfection Spring Company

4. The *age of chivalry* followed, during which the strong and warlike were also heroic—only to be exterminated during the Trojan war.

5. The *present age.* In a word, the *iron age,* with its mingled trials, tribulations and progress.

Archæological research has, for the most part, refuted the idea that the metals were brought into service by man in the following order, viz.: Gold, silver and then bronze; after which, iron. Archaeology tells us that, owing to its brilliant lustre and the fact that it occurs so frequently in the metallic state, *gold was the first metal known to the human race.*

Primitive man probably first witnessed the rising sun in Southeastern Asia, at all events, the *Pithecantropus erectus* was first found in Java. In the evolution of primitive man the time arrived when he hit upon the idea of weapons of defense. He fashioned them from wood, and, from bone, and then stone. Gold, as it was most likely discovered in grains and nuggets along the beds of streams, was fashioned into ornaments because of its glitter; but, it was not used for weapons on account of its persistent ductility.

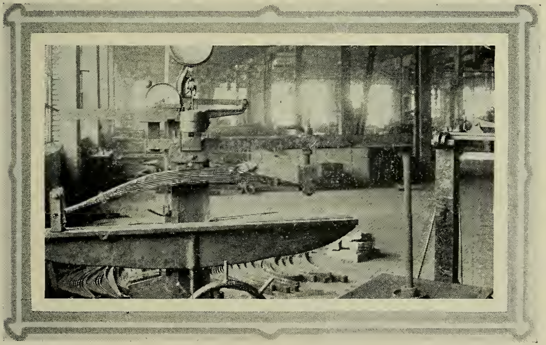
Environment played its strong part during the uplift of the human race. As man multiplied and spread, habitations sprung up in every type of adjacent land. Some lands were rich in mineral substances, while other zones were pastural. Trade, and barter; disagreement, and war; surplus, and famine, each in turn, influenced for transportation. Each, in a measure, established the need of weapons of offense and defense—a knowledge of the use of metals grew.

Archæologists and anthropologists fail to present complete accord on the subject of man's uses of metals.

Some say that iron came into use before bronze, others contend that bronze followed stone for the fashioning the tools of the chase and the implements of war. But, no matter, let us go on. From the standpoint of economic geology and through the eye of the metallurgist, the easily reducible iron ores are widely scattered over the earth's surface, what is more probable than that, basking in the favor of bounteous nature, iron became the *vogue* where this ore was to be had; whereas, bronze filled a long-felt want in its own sphere of influence.

Brief Resume of Users of Metals in History—From 10,000 to 8000 B. C.

Babylonia, district of Mesopotamia, peopled by Semitics, coming from the upper Tigris-Euphrates River region, mingled with descendants of primitive Aryan tribes, of Asia Minor. The mingling of these races gave



Willys-Knight cantilever rear spring under capacity-deflection test at The Perfection Spring Company

rise to Babylonian culture. Records of the ancient Babylonians, dating back to 5,000 B. C., tell us of their rites and customs. Tombs and graves of these ancients give up their precious possessions of intrinsic worth, including gold, silver and bronze ornaments—*but no iron is found.*

Contemporaneous Predynastic Egypt—From 4500 to 4000 B. C.

WHEN the *nomadic Semitics* under the impetus of a great wanderlust, pierced the land of the Nile Valley, they found others there to extend to them a *warm* welcome. Breasted is authority for the statement that these *predynastic people* were related to the Lybians of North Africa. It is also said of them that they fashioned the most cunning flints which were ever found among any people belonging to this age. They also produced implements of copper. Gold, silver and lead, while rare, were also in use.

How the workmen of The Perfection Spring Company look after their pressing needs without leaving the plant

From 4500 Down to 2300 B. C.

It is probable that within this period bronze

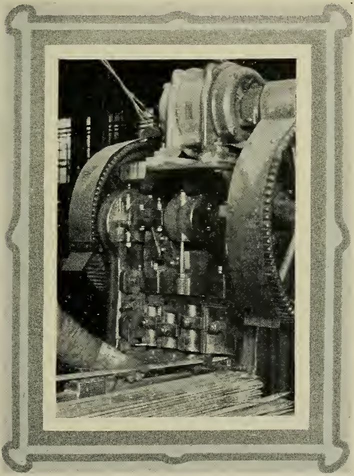
first came into use. It was introduced into Egypt between the twelfth and eighteenth dynasty, most likely about 2,000 B. C.

Rameses II.—1292-1225 B. C.

Iron plow-shares were used. Egypt procured much of its iron from Ethiopia.

Thutomes III.—1500 B. C.

Mention is made of the uses of lead. It has been recovered in Assyrian cities, viz.: Nineveh—the oldest known spoked-wheel was uncovered in a mummy pit at Nineveh. The writer has experienced the pleasure of examining and photographing this wheel. It is worthy of note here that the tire was made of wood.

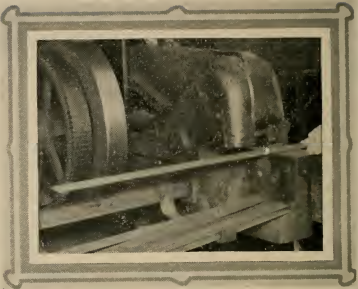


Trimming press at work in plant No. 2 of The Perfection Spring Company—individual electric motors used throughout the plant

From 1300 Down to 300 B. C.

The Phœnicians, never a nation in the true sense of the

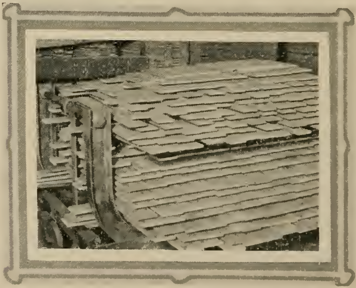
word, were, however, the greatest commercial people of the ancients, thriving under Egyptian, Assyrian, Greek and Roman rule. They were skilled metallurgists. A colony of these people on the Island of Cyprus, operated extensive copper ore smelters about 1300 B. C. They also accumulated stores of metal from distant people with whom they engaged in trade. Their most Western ventures in trade were with the Spanish (at Cadiz). The bronze industry thrived under the Phœnicians. It is said of this race of merchant-metallurgists that they mined iron in the Lebanon Mountains in Syria in the time of Solomon, 999 B. C.



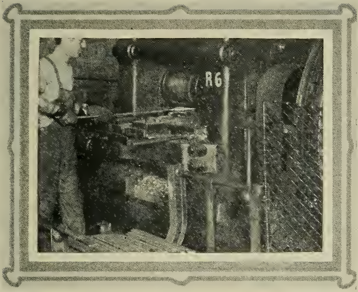
Motor-driven "trolley" shear, used in plant No. 2 for cutting off stock

Wootz Steel —1500 B.C.

India was an early producer in steel. Wootz steel was a famous brand 1500 B. C. Aden, on the Red Sea, was a great market-place in those days.



Truck load of plates from the cutting-off department en route to forging department

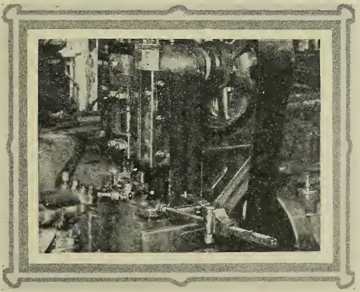


Motor-driven tapering rolls at work in plant No. 2 of The Perfection Spring Company

Welding was known to the Indians at an early date. In Delhi stands the Kutub column, a great mass of iron, partly buried, and approximately 59 feet long, tapering from 16 to 12 inches from bottom to top. This column is nearly pure iron, dating from 1,000 B. C., and it seems to be made of small pieces *welded together*. This column weighs 19 tons. In the temple of *Kanaruk,* wrought iron beams were found 20.6 feet long and three inches in cross-section, dating from 1,250 B. C.

Rome—400 Years Down to 412 A. D.

Under the Romans the uses of the metals became widespread. The chief copper supply for the Romans who succeeded the Phœnicians, was from Huelva, Spain. Iron came from the Island of Elba, from Spain,



Motor-driven beading and slotting machine operating in plant No. 2 of The Perfection Spring Company

Gaul, Illyria, and Britain, while tin, for bronze, came chiefly from Spain and Cornwall.

How the Ancients Made Iron

Easily reducible iron ore was mixed with charcoal and smelted in shallow pits in the ground, blast being furnished by means of skin bags through bamboo blast pipes. The product was a mixture of iron-sponge, clay, and undecomposed ore, which was again smelted with charcoal. The product was a hot, waxy mass of iron intermingled with clay. In other words, a "bloom." On the west coast of India this method obtains to this day.

Germany—About 1450 A. D.

The first production of cast iron traces back to Germany in 1450. From that time forward cast iron spread quite rapidly.

Tuyeres Introduced in Sixteenth Century

The first tuyeres or openings for the introduction of blast into the furnace were of stone. Copper tuyeres were invented in Germany at the beginning of the Sixteenth Century. Iron tuyeres followed in 1697. Coal took the place of charcoal in England in 1623—the device of Lord Dudley, so it is handed down. Belgium blast furnaces resorted to coal for the fuel in 1627. Abraham Darby began smelting with coked coal, or coke, in 1713. Richard Ford solved the problem of coke smelting at Coalbrookdale in 1742, making this plant the largest iron works in the world. Progress was rapid from that time forward. In 1768 Smeaton invented the cylinder blast engine, thereby greatly increasing the capacity of the furnace. The heated blast was made by Neilson in 1829.

1740 Brought the Crucible

In 1740 Benjamin Huntsman invented the crucible. Actual spring-making dates from the crucible. Prior to the crucible uniformity of product was out of the question. Then, too, spring steel is high in combined carbon. The crucible is capable of delivering high carbon steel.

Puddling Process Came in 1784

Henry Cort in 1784 made a great step in the process. He introduced the reverberatory furnace. Steel (making springs commercially possible), was the product of accidental discovery. When cast iron and wrought iron were charged on shallow hearth, the product, to the surprise of those who made the "mistake," was in the nature of steel. Of course, steel was even a prehistoric product by the "cementation" process.

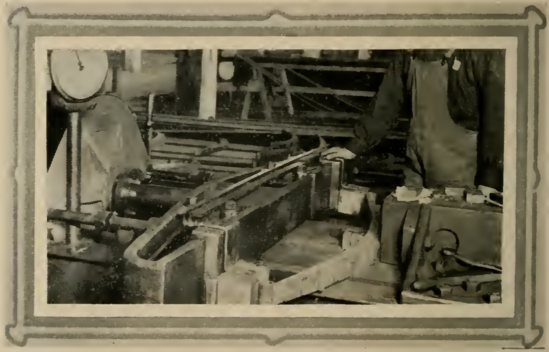
1856—Henry Bessemer Invented His Process

The quantity production of steel dates from the Bessemer furnace.

Early Days of Practical Spring Making

OBEDIAH ELLIOTT, an English carriage builder of substance, native of Lambeth, England, applied for letters patent on spring suspensions for vehicles in the year 1804, hence, recording a definite step in the art, introducing to the world a practical application of the full

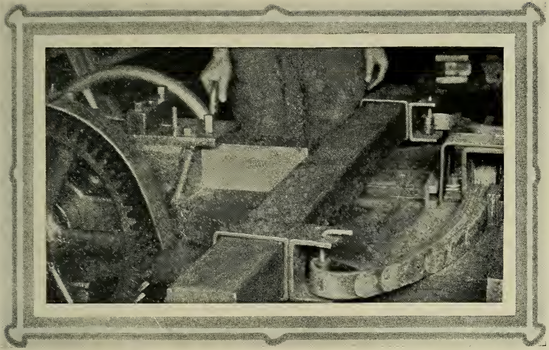
elliptic spring. But the history of spring-making, however vague back of 1804, would be incomplete without mentioning some slight attempts at cushioning vehicles against road inequalities as far back as 1750. Nor, was this early activity limited to England, although, the "Tight Little Isle" lays claim to the first efforts in this direction, which claim is clouded in a measure of controversy; both in France and in Germany mention is made of what we now term flat plate springs—certainly



Mammoth testing machine in plant No. 2 of The Perfection Spring Company, proving-out truck springs

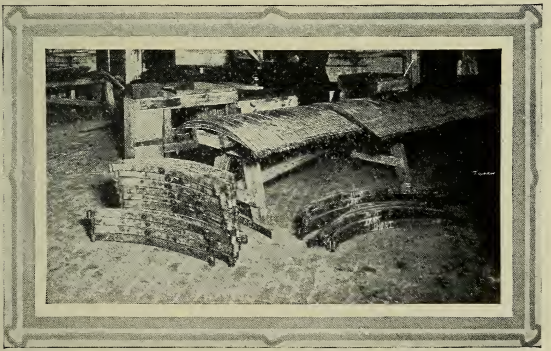
as far back as 1740—beginning with the crucible pot for the production of steel.

Our concern is not so much in the early history of flat-plate spring-making, as it is in the fact that progress has been slow in this field of industry; nor, are the reasons hard to find. It will be remembered that spring-making could scarcely progress in the absence of steel



Testing scroll hangers in plant No. 2 of The Perfection Spring Company

of the requisite quality and in quantity. Steel in quantity dates from Bessemer in 1856. It, therefore, follows



Assembled springs after being tested (those failing to come up to standard, being rejected) in plant No. 2 of The Perfection Spring Company

that real spring-making dates from Bessemer rather than from the crucible pot. Proof of the fact that spring-making could not have amounted to very much prior to the introduction of steel, in quantity, while it is not particularly necessary at this time, is in ample evidence in every museum in England, France, Germany and elsewhere on the Continent. The royal equipages of what we now call "antiquity" were either constructed without springs of any kind, or the bodies were suspended on leather straps.

In the days of "puddle iron" which preceded the introduction of steel in the crucible pot, it was extremely difficult to make springs because the iron was almost devoid of carbon. Carbonizing nearly pure iron is a slow and difficult process. The art of making springs really dates back to about fifty years ago, and in these fifty years, while it is true that considerable activity has been recorded, the fact remains that there was very little technical progress made. Spring-makers were never very scientific. As a matter of fact, they were the victims of their own secrets. If one of them by any chance discovered a process that promised something more than the parent state of the art provided, he kept it to himself. Real progress cannot be made through secrecy and stealth, it being true of the industries that the more progressive of them thrived and prospered at the cost of the least progressive among them.

But the backward condition of the spring-making art must not be entirely ascribed to the secretiveness of those who worked in the industry. No spring can be any better than the material of which it is made, and metallurgy itself is a distinctly modern institution. Indeed, all that we now know on the subject of metallurgy, is scarcely to be rated beyond the A-B-C of metallurgical possibilities. In proportion as the better equipped laboratories ascertained, by definite and persistent investi-

gation, points of interest and profit to the spring-maker, the art advances; but even now, there are not a half dozen well equipped laboratories in the world devoted in even a fair measure to the spring-making art, whereas, in America, there may be two well-equipped laboratories operating exclusively for the benefit of the spring-maker, but, *our personal positive knowledge extends to only one laboratory of this character*—the Perfection Laboratory, Cleveland, O.

Questions of Standardization Arise

THE problems of standardization thrust themselves into the issue. Realizing the benefits to be derived from standardization, it remains to be said, however, that before standards are susceptible of being crystallized, it will be necessary to know just what to standardize. Until a number of well-equipped laboratories are operated exclusively for the benefit of spring-making, it will be impossible to effect standardization for want of evidence. It is all very well to learn from the laboratory that certain things are likely to happen; that certain situations confront the spring-maker, and that they are likely to recur, but the fact remains that one man in the absence of corroboration has not a very convincing voice, and it is equally true in the spring-maker's art that one laboratory should not supply the standard. However, those who operate without the knowledge to be gained in the laboratory *should have no voice in making standards.*

However much the problems of standardization are in need of laboratory information, the fact remains that there are some situations so self-evident as to be worthy of consideration. For instance, there is no advantage in

At the assembling bench in plant No. 2 of The Perfection Spring Company

the present practice of employing such a large number of widths of steel. The fabricators of steel will decline to carry them in stock. It is more to the point to fix upon a limited number of widths of steel such as may be looked upon by the fabricators of steel as good stock to carry. Again, it is not fair to the steel-maker to ask him to supply sample lots of "jewelry steel" for purposes of

A cord of half-elliptic springs in the finishing department of plant No. 2 of The Perfection Spring Company

Forming spring plate over a "master" at plant No. 2
The Perfection Spring Company

commercial exploitation, and thereafter, order from that

Cord of completed Overland springs passing out the finishing department at plant No. 2
of The Perfection Spring Company

The Perfection Spring Company's Executive Staff (From left to right).
Z. B. Leonard, Treasurer E. W. Farr, Secretary P. A. Conn
H. E. I

O. Blanchard, R. K. Johnson, W. E. Perrine, John G. Utz, Thos. J. Fay, Professor
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steel-maker quantities of inferior product. It is not necessary to go into the laboratory to look for honesty. Nor is it possible to induce the steel-maker to believe that a laboratory is in good business calling for "quality" samples and thereafter placing "quantity" orders.

Referring to quality, the old-fashioned spring-maker had one idea, which was not a bad one in his time. He took into account the fact that the spring is made up of a plurality of superimposed plates. It was not difficult for him to see that a defect in one plate was over-lapped by steel without defect in the adjacent plates. It represented the same thing as in a built-up wooden beam, it being the practice of the wood-worker to employ a number of planks in the beam and reverse the grain of the laminae, in order to get away from the ills of knots, checks and other imperfections residing in the wood. In a word, a flat plate spring, no matter how good or how bad the material therein may be, or what the heat-treatment, is self-protecting in a large measure for the very simple reason that the imperfections in one plate are supported by more perfect material in the adjacent plates.

Not a few of those old spring-makers have survived the wiles of time, and we have carried along in the art of spring-making not only the fallacies of by-gone days, but they still persist in taking advantage of the things that proved to be of advantage from the first inception. In the meantime, as modern testing equipment adequately shows, there is all the difference in the world between a well-designed spring composed of fine material, and rule-thumb product of the old-fashioned spring-maker.

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